Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

ing infancy, he finds one set of constants to represent the Carlisle Table from 10 to 60, another from 60 to 100. Mr. Edmonds finds the same necessity, but he also takes in the period of infancy, and applies the law to the periods from birth to 8 years of age, from 12 to 55, and from 55 to the end of life, acknowledging that the periods vary with circumstances.

Mr. Gompertz considers, as appears by one of his examples, that the constant q is very slowly varying during the period at which it is near enough to uniformity for practical use. Mr. Edmonds seems to assume that during each whole period of its use, his constant q is absolutely fixed; but of this he does not give any evidence. For the logarithms of q, by the Carlisle Table, from 10 to 60, and from 60 to 100, Mr. Gompertz has 0·0126 and 0·0271. In Mr. Edmonds's book, the logarithms of p, from 12 to 55, and from 55 to the end of life, are 0·0128 and 0·0333. Mr. Edmonds calls his constants "now first discovered" (p. vi.).

I can find nothing in which Mr. Edmonds went beyond Mr. Gompertz. It is now for him to show that he not only went beyond Mr. Gompertz, but so far beyond that all which was due to Mr. Gompertz was comprised in the statement that the whole of what I have quoted gives the *single common point* that a^{b^x} has *some connexion* with tables of mortality. Should he wander from this point—which is *the* point—it will be my part to request insertion of a short exposure of irrelevancy. I will conclude by observing that I do not care to inquire whether or no what Mr. Edmonds published, as above quoted, was done independently of Mr. Gompertz, as asserted. On this point it will be well to suspend opinion until it is seen what Mr. Edmonds can say in justification of the suppressive mention which, I submit, has been fully established.

On some Considerations suggested by the Annual Reports of the Registrar-General, being an Inquiry into the Question as to how far the Inordinate Mortality in this Country, exhibited by those Reports, is controllable by Human Agency. (Part II.) By H. W. PORTER, ESQ., B.A., *Assistant Actuary to the Alliance Assurance Company, Fellow of the Institute of Actuaries and of the Statistical Society.*

[Read before the Institute the 27th February, 1860.]

WITH respect to the inhalation of woolly matter, Mr. Leigh, a surgeon at Manchester, and Registrar of Deaths for the Deansgate sub-district of that city, in which cotton-mills are so numerous, states, in one of his Reports to the Registrar-General, that in certain trades in Manchester almost every member above 40 is affected with emphysema of the lungs; and that persons who work in dust—as fustian-cutters, cotton-carders, and the like—are almost all affected with it, after working at their occupations for a few years.

This disease, which is also called "pneumatosis," is not often to be found recorded as a cause of death in the Registrar's returns, probably because the disease usually turns to bronchitis, and the deaths, which are caused primarily by emphysema, come to be registered under the head of "bronchitis."

Considerable injury also is said to be caused by the inhalation of fuliginous particles, with which the atmosphere of large towns is so generally impregnated.

It is common to find, after death, Mr. Leigh reports, the bronchial glands and pulmonary tissue perfectly black, from the presence of carbonaceous matter.

The Acts lately passed, providing for the compulsory consumption of the smoke produced in manufactories—the application of which will in course of time, no doubt, be extended all over the country, but which do not, I believe, at present apply to Manchester, or other large manufacturing towns—will gradually tend to remove this source of disease.

Some advantage is considered to have been derived by workmen engaged in occupations from which they are exposed to the inhalation of dust and other obnoxious matter, by the practice, which has lately become very general, of allowing the beard and moustache to grow, at the suggestion of a physician in Edinburgh, the late Professor Alison.

The movement was commenced, I believe, by the stone-cutters in Scotland. In many occupations, where the inhalation of metallic particles is to be apprehended, wire masks have been introduced, with the object of arresting the progress of particles which might enter the mouth, nostrils, or eyes; and magnetic guards, when the metal that is being worked is steel or iron: the intended object is, of course, to some extent effected, but the mortality among workmen engaged in these processes of manufacture shows, too clearly, that the effect is but partial, and the use of such contrivances is far from general.

I am aware that it is popularly considered that the entry, by inhalation, of particles of foreign matter into the bronchial tubes and lungs, or, at any rate, their remaining there, is rendered impossible by reason of the ciliary action.

I am induced to refer to this matter, because I find the error perpetuated in a recently-published Magazine, edited by Mr. Thackeray, whose name carries so much weight with the public that it may be as well to enter a little into the question.

The writer of the article, which is entitled "Studies in Animal Life," after describing the nature of the cilia, states as follows, that "while the direction in which the cilia propel fluids and particles is generally towards the interior of the organism, it is sometimes *reversed;* and, instead of beating the particles inwards, the cilia energetically beat them back, if they attempt to enter. Fatal results would ensue if this were not so. Our air-passages would no longer protect the lungs from particles of sand, coal-dust, and filings, flying about the atmosphere; on the contrary, the lashing hairs which cover the surface of these passages would catch up every particle, and drive it onward into the lungs. Fortunately for us, the direction of the cilia is reversed, and they act as vigilant janitors, driving back all vagrant particles." "In vain," it is stated, owing to the direction of the cilia being reversed, as it is in man, "does the whirlwind dash a column of dust in our faces—in vain does the air, darkened with coal-dust, impetuously rush up the nostrils: the air is allowed to pass on, but the dust is inexorably driven back. Were it not so, how could miners, millers, ironworkers, and all the modern Tubal Cains contrive to live in their loaded atmospheres? In a week, their lungs would be choked up." "Perhaps," continues the writer, "you will tell me that this *is* the case: that manufacturers of iron and steel are very subject to consumption; and that there is a peculiar discoloration of the lungs which has often been observed in coal-miners, examined after death."

I shall certainly tell him that the highest medical authorities have no doubt whatever as to the possibility of the entry by inhalation of particles of foreign matter into the respiratory apparatus. It is a matter of fact that carbonaceous matter is found in the lungs after death. Mr. Queckett, the Conservator of the Museum of the Royal College of Surgeons, and Professor of Histology there—and a more competent authority I can hardly, I conceive, bring forward—has repeatedly found carbonaceous matter as the nucleus of tubercle, examples of which he has been kind enough to show me under the microscope, in which inhaled matter of this description formed clearly the nucleus of the tuberculous matter; and there is said to be little reason to doubt that such matter not only forms the nucleus of tubercle, but that it is often the exciting cause of tuberculous deposit.

The writer of the article to which I have just alluded does not, I think, very clearly describe the action of the cilia, which is not of a nature to *prevent* the entry of foreign particles into the lungs, but, by means of the reversed action to which allusion has been made, to *expel* them from the lungs after they have reached those organs ; and this, to a certain extent, no doubt they do.

Dr. Carpenter, one of the first authorities on the question of animal physiology, thus describes the cilia :—" The larynx, trachea, bronchial tubes, and air-cells of the lungs, in all air-breathing vertebrata," he says, " are lined by a mucous membrane, which is continued from the back of the mouth; and this membrane, like the gills of aquatic animals, is covered with cilia, which are in continual vibration." He explains that the purpose of this ciliary movement must be here different from that which is fulfilled by the same action on the surface of the gills of polypes, and which is stated to be to cause a constant change in the water that is in contact with their surface, and so to secure a constant supply of the air contained in the water.

Dr. Carpenter describes the cilia to be " minute vibrating hair-like filaments ;" and the purpose of the ciliary movement "probably serves," he explains, " to get rid of the secretion which is being continually poured out from the surface of the mucous membrane, and which, if allowed to accumulate there, would clog up the air-cells, and in time produce suffocation."

The constant vibration of the cilia always in one direction, towards the outlet, no doubt serves to get rid of foreign particles which have effected an entrance into the lungs—not, as stated by the Magazine writer, to *prevent* their entrance. It serves to get rid of them to a certain extent, but the power of this action is probably quite insufficient to cause the ejection of the whole of the very great quantity of different dusts, and of the stony and metallic particles, which the constant exposure of persons subjected to such noxious influences might cause to enter the respiratory apparatus; and we may draw this conclusion because we know, from ocular observation, that the power of the cilia is insufficient to expel from the lungs the carbonaceous matter, which, being of a lower specific gravity, is far more likely to be driven out than the stony and metallic particles, of the presence of which in the lungs it is difficult to bring forward actual proof. Seeing, therefore, that the cilia have not the power to eject the carbonaceous matter, we may not unfairly conclude that if the particles of the higher specific gravity alluded to are not to be found after death, their absence may be ascribed to some other cause than to that of the ciliary movement. The assumption, therefore, of the author of the Magazine article, that "although consumption may be frequent among the Sheffield workmen, the cause is not to be sought in their breathing filings, but in the sedentary and unwholesome confinement incidental to their occupation," I look upon as wholly untenable.

With reference to the peculiar discoloration of the lungs of coal-miners, which has been observed, the writer says, in some, but not in all or in many, of those engaged, and which has been observed as well in persons who were not miners, and who were not exposed to the influence of any unusual amount of coal-dust, I may refer to the reports of Mr. Leigh, the Registrar of the Deansgate sub-district of the city of Manchester, from which I have already quoted, and I would ask, whether those persons referred to as not being exposed to the influence of coal-dust to any unusual extent, were not, equally with all the inhabitants of large towns, exposed to the influence of the fuliginous particles with which the atmosphere is constantly impregnated, and evidence of the inhalation of which has already been adduced? On the other hand, it is true that evidence of the deposit of pigment in the cells of the lungs, as well as of an entire change of colour of other organs of the body, is to be found in our collections of morbid anatomy.

The ciliary action may be seen to advantage in the living oyster and mussel—in the latter particularly—in a portion taken from the gills, and viewed with a magnifying power of 200 diameters or upwards. An obvious agitation of the water, caused by the unceasing movement of the cilia, is clearly to be seen. Mr. Queckett has discovered that the cilia have a feathering action, like an oar, the object of which seems to be to prevent their motion producing two currents in opposite directions, the result of which would be to counteract altogether the effect intended to be produced. This he has observed in the mussel, and it is fair to assume that it is the same in the human subject, in which it is not easy to find the opportunity of witnessing the experiment, as the ciliary action is not visible for more than about 12 hours after death.

The ciliary motion of the human mucous membrane can, however, be seen for a much longer period on the surface of a recently extracted nasal polypus.

The ciliary action, which must be seen to be appreciated, forms altogether one of those wonderful provisions of nature of which the microscope is now every day opening up a fresh store, to delight, instruct, and astonish us.

The great and concluding argument, however, against the possibility of the inhalation of foreign matter, the writer of the article under consideration tells us, is found in an experiment by Claude Bernard on a rabbit, over the mouth of which a bladder containing powdered charcoal was tied, so that whenever the animal breathed the powder would be likely to be inhaled. The bladder was kept on constantly, except at feeding time, for many days, and yet, it is stated, when the rabbit was killed no charcoal was found in the lungs or bronchial tubes—the cilia being considered to have acted as a strainer, and to have kept the particles of the dust from the air tubes.

Now, from what has been said, it will appear that no such thing took place. If the cilia did act in the matter—which, possibly, they did to some extent—it was by expelling the noxious particles after they had entered the air tubes; but, I look upon it, other reasons could be adduced to account for the absence of the particles of charcoal from the lungs; for instance—

1st. Because the process was probably not continued sufficiently long to counteract the effect which the cilia, it is admitted, have, to some extent, in expelling from the respiratory organs particles of low specific gravity.

2nd. Because, owing to the low specific gravity of charcoal (which is, when in powder, 1·5 only, while that of stone, marble, granite, and slate, I may mention for comparison, varies from 1·7 to 2·85, and that of iron and steel is respectively 7·788 and 7·81), it would be very easily affected by the ciliary movement.

And 3rd. Because there is a peculiarity in the construction of the lungs of rabbits which might have influenced the experiment—the minuteness of the subdivisions of the lungs of those animals into small cavities or air cells being just of a nature to favour the experiment of Claude Bernard.

I may mention another fact which favours the opposite conclusion as to the inhalation of foreign bodies into the respiratory organs—namely, that experiments have shown that animals can be made phthisical by the introduction of particles of metallic mercury into the lungs.

The elaborate investigations, however, of Dr. Holland, physician to the Sheffield General Infirmary, entirely set at rest the question of the injurious effect on the lungs of grinding in all its branches.

I shall, hereafter, more particularly allude to the inquiries of Dr. Holland.

M. Morni, in a communication to the Academy of Sciences in Paris, stated that the sword-makers on the continent die before attaining the age of 40 or 45 years. Deslandes, an eminent French writer, mentions, in his *Dictionnaire de Médecine et de Chirurgie Pratiques,* that polishers of steel scarcely reach their 36th or 40th year, and that those are considered to be old who attain the age of 45.

It is necessary to be most careful how we receive as positive facts statements put forth in popular articles on scientific subjects, lest we may be led into error. Professor Babington, with reference to the examinations in natural history at Cambridge, speaks of the inaccuracies contained in popular books on the natural sciences, on which point he thinks it necessary to caution the students of the University.

There is no doubt that many popular errors are perpetuated by means of the elementary handbooks on scientific subjects so much in vogue at the present day; and among the retarding influences with which sanitary reformers have to contend, are the prejudices founded upon errors to which those who hold them often most obstinately cling.

The evidence of the inhalation of stony and metallic substances into the respiratory organs that I have been enabled to obtain is but of a negative character.

With the exception of the carbonaceous matter that I have referred to, I have not been able to *see* any foreign particles that had been received into the lungs by inhalation.

I have taken some trouble to ascertain if any preparation existed showing the fact, and have ascertained that there is no such preparation in the Museum of the College of Surgeons in London. I found several specimens of calcareous and earthy matter—carbonate and phosphate of lime principally—which had been taken from the lungs of oxen and other animals, but this was the result of the ossification of tubercle.

I have not been able to ascertain, upon inquiry of several medical men in London, of the highest standing and experience, that they have ever actually found any stony or metallic particles in the lungs, as the result of inhalation, though no doubt seems to exist as to the fact that such bodies *do* effect an entrance, of which, indeed, the presence of carbonaceous matter, which is repeatedly found, is sufficient evidence.

One case of a mason has been mentioned to me, in which such a discovery is stated to have been made after death; but my informant had not the facts of the case at his command, and it is very possible that the deposit in this case was the result of disease, and not of inhalation.

The absence of such appearances at the autopsy are accounted for pathologically from the fact that the irritation of their presence induces inflammation, and the particles, in consequence, become detached and are expectorated. This, it is easy to understand, may be the case to some extent; but it is scarcely conceivable that the very large quantity of foreign particles that are likely to be inhaled by persons engaged in certain occupations should be so effectually ejected in this manner as to leave no traces after death of their former existence.

It seems reasonable to suppose that, unless a *post mortem* examination were made with the special object of detecting evidences of the inhalation of foreign particles, they might, from their minuteness, escape observation; and yet, minute though they be, they might have quite sufficient power to cause most serious mischief, by the mere mechanical irritation produced by their contact with the delicate surface of the mucous membrane, in the same way that in poisoning by strychnine, though the actual presence of the poison in the nervous tissue might escape detection from the extreme minuteness of the crystals, still death by that poison may, nevertheless, be the result of the mechanical irritation of the nerves of the body by the sharp, angular, and indissoluble crystals of the strychnine. I am now assuming the truth of a theory which has been propounded to account for the way in which death from this poison is produced—viz., by the actual mechanical action of the sharp-pointed angles which result from the crystallization of strychnine, and which work their way into the substance of the nervous fibre, it being a characteristic of this poison that the crystals are of a peculiarly indissoluble nature. In fact, it is only in microscopical preparations of portions of the lungs that such particles, as from their minuteness have the power of entrance, are likely to be observed. A particle of stone or metal sufficiently minute to be inhaled, would generally occupy far less space than a particle of carbonaceous matter; and yet such a portion of the latter as is likely to be found forming the nucleus of tubercles, when magnified 250 times, appears only about the size of a moderate-sized pin's head.

Thackrah mentions that Diemerbroek relates that he had found, in dissecting the bodies of masons, heaps of sand in the lungs; and that, in dividing the pulmonary substance, he seemed to be cutting a sandy body. Thackrah, however, suggests whether the sand thus found was inhaled, or whether it was not rather a calcareous deposit formed by disease.

From what I have said as to the specimens of calcareous and earthy deposits preserved in the museum of the College of Surgeons, which were found in the lungs of animals, and which arose, in fact, from the ossification of tuberculous matter, it is not at all unlikely that the idea of Thackrah was correct.

The expectoration of calcareous matter, moreover, is not uncommon in some of the stages of phthisis, showing clearly the existence of such matter in the lungs, as the product of disease.

It is further stated, in the Magazine to which I have already referred, that "although consumption may be frequent among the Sheffield workmen, the cause is not to be sought in their breathing filings, but in the sedentary and unwholesome confinement incidental to their occupation."

Surely the writer of this article can hardly be aware of the extensive medical investigations that have been instituted into this subject! I have before referred to Dr. Holland, whose official connection with the Infirmary at Sheffield—the head-quarters of the grinding trade—afforded him the fullest opportunities of satisfactorily determining the effects of this occupation on the health of the operatives, while the fact of this physician having studied under the celebrated Laennec, rendered him most peculiarly competent to undertake such an investigation.

Dr. Holland has minutely inquired into the effect produced on the respiratory organs, by the inhalation of metallic particles, upon workmen employed in all the different branches of this trade—viz., upon scissor grinders, upon fork, needle, razor, penknife, table-knife, saw, file, and scythe grinders; and has shown, beyond the possibility of question, that such occupations are absolutely lethal in their nature. Thoracic diseases, Dr. Holland tells us, are prevalent to a great extent in Sheffield, and are more owing to the effect of dry grinding than to that which is done on wet stones.

It is in the grinding of small articles, such as needles, penknives, &c., that the greatest amount of dust is produced; and the evils entailed in these branches are accordingly greater than those resulting from the grinding of saws and scythes, which are ground on the wet stone only. The want of proper ventilation to carry off the dust is one great cause of the sufferings of the grinders, who are constantly working in clouds of dust. Without quoting the pathological reasons which lead to the conclusion, I may mention that it seems to be considered that the mucous membrane of the air passages is the seat of the disease from which the grinders suffer—grinders' asthma—the tendency of which is to terminate in tracheal consumption.

Tubercles, however, are found in numerous cases in the lungs of grinders, and can be traced to the inhalation of dust; and many —the delicate in constitution particularly—die very early of a disease more nearly approaching to tuberculous phthisis.

The principal mortality among these operatives takes place between the ages of 21 and 35, and not many appear to survive much beyond the latter period, while the more delicate in organization die long before attaining the age of 35.

There seems to be no reason to doubt that the disease of which grinders die, whether it be bronchial or tubercular consumption, is produced from the mechanical irritation of the hard metallic particles upon the delicate surface of the mucous membrane. In the later stages of the disease, hard, black, and gritty masses are not unfrequently expectorated, which are stated to appear to be accretions of dust, as large as a pea, and even larger. Some grinders expectorate these masses for years; and the fact that extensive expectoration of this nature goes on throughout the progress of the disease, would appear to account for the very rare discovery of the accumulation after death; another reason for the non-discovery being, that the workman is not exposed to the inhalation of dust for some time previous to his death, as he is incapacitated from following his occupation for months prior to the fatal issue. The position of the grinder while at work has, no doubt, a most injurious effect, the body being bent nearly at right angles, so that the lungs have not the free play so necessary to keep them in a healthy state. The remuneration of this class of workmen is low, notwithstanding the deadly nature of their employment; and they are stated to be reckless and dissipated, so that the fatal results which ensue from their occupation are, in many cases, unnecessarily hastened.

I have previously spoken of the want of knowledge of the labouring classes as operating against any speedy amendment of their sanitary position. Dr. Holland refers to the ignorance of the Sheffield operatives as tending, in the first place, to induce them entirely to disregard the premonitory symptoms of their illness; and, in the second place, as tending to make them consider that such evil results are necessarily inherent in their calling.

We see from these, and many similar considerations, the importance of introducing some instruction in human physiology into the ordinary routine of education, as the only means of teaching the results that must necessarily ensue if the laws of nature are disregarded, and of showing the labouring community how much it rests with themselves to guard against many of the evils from which they now suffer, and which are, to so great an extent, capable of being remedied.

A peculiar appearance is mentioned as being often observed in *post mortem* examinations of the respiratory organs of grinders: this is, a change of structure of the bronchial glands, at the bifurcation of the trachea. They seem to be converted into a black, gritty substance, the composition of which is unknown. This abnormal condition seems to be the result of the more destructive branches of the trade, such as fork-grinding. These gritty bodies are also found in the lungs, and are usually about the size of currants, but they are found much larger, and, at the bifurcation of the trachea, even as large as a hazel nut. More than a quarter of a century ago an invention was introduced by Mr. Abraham, which, it was hoped, would tend to diminish the fatal results caused by the inhalation of metallic particles. This was, a magnetic guard for the mouth; the object of which was to attract the particles of metal, and so prevent their entrance into the respiratory organs. The invention, however, does not appear to have been generally adopted, and it has long since fallen into disuse.

The dust produced in grinding is stated to consist of gritty as well as of metallic particles; the latter alone would be arrested in their course by the magnets, and the gritty particles are said to be no less injurious than the metallic. Great prejudices, however, exist among the workmen against all inventions of this kind, and it is very difficult to make them see the advantage of them, to whatever point of perfection they may be brought, and however fully they may be shown to answer the end in view.

It became, accordingly, a desideratum to introduce some arrangement, the success of which should not depend upon the men, and a contrivance was invented with this view. This was, a wooden funnel, from 10 to 12 inches square, placed above the surface of the revolving stone, on the side the farthest from the grinder, terminating in a channel immediately under the surface of the floor. Each of the grinders working in the same room has his own funnel and channel, all of which terminate in a common channel close to the external wall, where a fan is placed, like those used for winnowing corn, so arranged as to cause a current of air to flow from the mouth of the funnels, the effect of which is to carry away all the particles thrown off from the wheels. The principle is similar to that which I have before described as having been introduced into Mr. Evans' flour mills.

This arrangement is still in use in the different works in Sheffield, but no legislative enactment compels its adoption. Notwithstanding the continued use of the invention, however, the most recent inquiries into the mortality of the manufacturers of cutlery in Sheffield and elsewhere show that the high mortality among this class of operatives still continues. Dr. Greenhow, to whom reference has previously been made, states that "the greatest excess of death-rate is in Birmingham, Ecclesall Bierlow, and Sheffield, where, especially in the two last-mentioned places, the finer kinds of metallic manufactures are made." "The pernicious influence on health of certain operations connected with the manufacture of cutlery," he adds, "has long been recognized, and it is here rendered evident by the high pulmonary death-loss among the males of Ecclesall Bierlow and Sheffield."

If, then, we suppose that the apparatus in use to carry off the dust is really and entirely effective, we must come to the conclusion that the high pulmonary death-rate is due to other causes—in a great measure, perhaps, to the bodily position of the workmen employed in the process of grinding, and to which reference has already been made. For this there seems, at present, to be no remedy, as the men explain that they cannot, in any other posture of the body than that which they habitually adopt, obtain the necessary purchase for keeping the article they are grinding in its due position on the wheel. It seems unlikely, however, that the inventive art of this country would be unequal to the production of some apparatus to prevent the injury thus accruing, should it be clearly shown to exist. To give an idea of the excessive mortality among the operatives employed in the Sheffield grinding trade, I may mention, that, in the fork-grinding branch—which is stated to be the most destructive—Dr. Holland found that, out of 1,000 deaths occurring among persons between the ages of 20 and 30, while the proportion in England and Wales was 160, among the Sheffield fork-grinders it was 475. In the next decade of ages, 30 to 40, a similar disparity was observed, the proportion in England and Wales being 136, and among the fork-grinders 410.

The mortality in this branch of the trade was, therefore, very nearly three times as great as that among the general population of the country. Carrying the inquiry a step further, we find that, between the ages of 40 and 50, the proportion for England and Wales was 126, and among the fork-grinders 115.

The sum of these three numbers, which indicate the deaths of the Sheffield workmen, it will be observed, is exactly 1,000, so that before reaching the age of 50, every operative engaged in this perilous branch of the Sheffield trade has actually been killed off, while the proportion of deaths per 1,000 among the population of England and Wales amounted only to 422. These investigations were made some years ago, but, as I have before observed, the inquiries of Dr. Greenhow show that the mortality of this class of operatives is, at the present time, most excessive, as is evidenced by the high pulmonary death-rate in Sheffield and in other places in which the manufacture of metals is carried on—the death-rate from pulmonary affections, per 100,000 males, being, for England and Wales, 569, while for Sheffield it was as high as 839, and nearly the same for Birmingham—viz., 838. In Ecclesall Bierlow it was 736.

In Sheffield the operatives are chiefly engaged as cutlers, file-makers, grinders, and other workers in steel, and as goldsmiths; in Birmingham, as brassfounders, button makers, goldsmiths, gunsmiths, iron manufacturers, tool makers, nail makers, and glass makers, and in Ecclesall Bierlow, chiefly cutlers, file makers, grinders, and other workers in steel. A very large proportion of the inhabitants of Sheffield and Ecclesall Bierlow are employed in the injurious occupation of steel working—the proportion of adult males engaged in metal manufactures in the former place being 40·9, and in the latter 43·6 per cent. Notwithstanding the improvements that have been introduced into the workshops of the Sheffield grinders to prevent the evil consequences which have been shown to result from the inhalation of the products of the grinding of metals, and particularly of the dry-grinding process, there is abundant evidence that the evil is diminished only, and not entirely prevented; and the mortality that, at the present time, still takes place annually among grinders at the principal seats of manufacture of metals is clearly too high to be the result of the "sedentary and unwholesome confinement incidental to their occupation," which the writer of the article in the Magazine to which I have referred seems to consider the cause of the frequency of phthisis among the operatives of this class. It will be evident, from the satisfactory action of the inventions for remedying the fatal effects that result from this branch of trade, that the means of diminishing the high mortality that, at the present time, still obtains, are in our own hands; but the influence of the Government to compel the due adoption of the means at command seems to be imperatively necessary.

To show to what extent proper attention to check the inhalation of dust may tend to diminish the mortality from pulmonary complaints, which exposure to its influence creates, I may refer to some statistics of the Pentonville prison, the discipline of which enforces the separate system. Several trades are carried on by the prisoners, some of which, such as mat and rug making, produce great quantities of dust, the inhalation of which by the prisoners, it was considered, might tend to the production of the high mortality from pulmonary disease which the records of the prison showed. An investigation into the sanitary condition of the prisoners was accordingly instituted by Dr. G. Owen Rees, the principal medical officer, in whose Report on the subject, appended to the Report of the Commissioners of the prison, the result of his inquiries will be found recorded. The prisoners in the Pentonville prison, it is stated, were more subject to injury from the inhalation of dust than those in prisons where the men do not sleep in their work-rooms. The investigation into this question was made on the 14th March, 1846, when the prison was full.

The proportion of men employed in dusty, as distinguished from those engaged in non-dusty occupations, was, at that date, as 1 to 2·38—so that, if the chances of death from consumption were equal for men employed in both ways, it would have been expected that more than twice as many cases would have occurred among men employed in non-dusty trades; but 8 men employed in dusty trades appeared among the casualties, which, were the chances of immunity equal, would give 19·04 for the number of deaths and free pardons among the non-dusty trades.

It is clearly necessary to include the free pardons on medical grounds as deaths from pulmonary disease, in all these comparisons, as, had not the pardons been granted, it is quite clear that death from such disease would have happened within the prison.

The result of the inquiry of Dr. Rees, however, he reports, did not show this to be the case, for only 9 of such men suffered, showing that the chance of escape from the disease in the prison was twice as great for those employed in the non-dusty trades.

Acting on the information thus obtained, means were taken to lessen the evils shown to result from dusty occupations. The winding of worsted was prohibited, the coir used in mat-making was ordered to be picked and beaten before being given to the prisoners to work up; and, probably, other measures, not detailed in the Report, were adopted to diminish the evils that were shown to have been the consequence of the inhalation of dust; and the result became apparent by the end of the year 1846, when the deaths by consumption scarcely exceeded the returns for the general population at the same ages—being, including free pardons, ·47 per cent. It therefore appeared that consumption in the Pentonville prison was an accidental, rather than a necessary, accompaniment of the system of discipline carried on there. Dr. Rees reports that the result of his investigation satisfied him that the admission of dust, of an irritating character, into the minute structure of the lungs, and particularly in occupations that require workmen to remain in an atmosphere of dust, leads to an excess of mortality by consumption; and that such is the case whether the dust created consists of metallic or of vegetable particles.

The result of this inquiry is important in two ways:—

1st. As showing that prison discipline, even when carried on upon the separate system, is not necessarily the cause of the tubercular cachexia, which has always been considered to be one of the evils of confinement in prisons; the improvements adopted with reference to the prevention of the inhalation of dust by the men, and the great attention devoted to ventilation, drainage, and the sanitary arrangements of the prison generally, under the able and zealous directions of Dr. Rees, having had the effect of so reducing the mortality of the prison, that, including all free pardons as deaths, the total mortality came but little to exceed that of the general population—the excess being 1·73 per cent. per annum—showing most satisfactorily the efficacy of the introduction of the sanitary measures recommended:

And 2nd. As evidencing how much we hold in our hands the means of diminishing the mortality from phthisis and other cognate diseases, which cut off, in the very prime of life, so large a proportion of the population of this country.

In our inquiries into the subject of pulmonary disease, we must not fail to consider the high mortality from this cause in the British army on home service. This question has recently begun to attract attention.

The disclosures in the Report of the Commissioners appointed in May, 1857, to investigate the sanitary condition of the army, were more startling in their nature than the public were prepared to expect.

It appears that one of the greatest enemies the soldier has to fear, far more than the sword or the rifle of the enemy, is the disease we are considering—phthisis.

It will be impossible for me, within the limits of this paper, to do more than give a slight outline of the causes tending to produce the effect observed.

Notwithstanding the circumstance of the soldier being, in fact, a selected life on entering the army, and that he is proved to be then free from any bodily defect or infirmity—notwithstanding that he is placed in a much better position than the rest of the community of the same social standing with himself, as to food, lodging, and clothing; that he has the best medical attendance upon the slightest suspicion of illness; and that, altogether, his position is one which might naturally be imagined must conduce to a high state of bodily health and to a lengthened existence—notwithstanding all this, the result of the inquiry is stated to be that the mortality in the army is very much greater than among any class of civilians.

At a meeting held lately at the Hanover Square Rooms, on the subject of the sanitary condition of the army, it was stated, by Dr. Gourlay, that the life led by the Guards in town unfits them entirely for campaigning; and that, upon the occasion of the Crimean war, after one night in the trenches, a great proportion of the newly-arrived soldiers were on the sick list.

It was stated further, that while the death-rate in the Prussian army was only 6 in 1,000, that in the British army was no less than 33 in 1,000, or nearly six times as great, and that 70 per 1,000 were invalided—a severe loss, even in a pecuniary point of view, to the country, when it is considered that each soldier, after he has learnt his duties, has cost the nation the sum of £100.

I am not aware what authority Dr. Gourlay had for this statement; as it appears, from the evidence of Colonel Tulloch before the Commission, that the mortality in the Grenadier Guards was 21·5 per 1,000—an enormously high rate as compared with that of the civil population, which was stated to be only 9·6 per 1,000 at the same ages—viz., 20 to 25.

The principal causes for this high rate appear, from the evidence before the Commission, to be—

1st. Defective arrangements connected with night duty.

2nd. Want of exercise and suitable employment.

3rd. Intemperance and vice.

4th. Bad barrack accommodation.

5th. Improper food and cooking.

Now, without going into any discussion of these five heads, there can be no doubt that the evil results traceable from such causes as these are within our power to remedy, and it is, accordingly, very satisfactory to learn that the Army Medical Department is now being reorganized by the Director-General, with the object of carrying out the recommendations contained in the Report of the Royal Commissioners for the improvement of the sanitary condition of the army.

A new statistical nomenclature, we are told, has been adopted for the army returns—viz., that which was drawn up at the Statistical Congress held in Paris in 1855, and which is identical with that of the Registrar-General; so that, in future, we shall be in a better condition to compare the mortality of our army with that of the armies of foreign powers, as well as with that of the civil population of this country.

One great cause of the maintenance of the high rate of mortality from phthisis, is, no doubt, the intermarriage of persons in whom the hereditary taint of this disease exists.

There is a theory put forth by Walker, that if one parent be afflicted with pulmonic disease, it is an even chance that any one child that may be the result of the marriage of two persons so situated should derive the organs of the chest from the parent so afflicted; and it has been suggested that this theory might account for the very capricious selection that this disease makes in the different members of the same family for its attacks.

Be this as it may, we know perfectly well that the hereditary transmission of this malady is an undoubted fact; and Assurance Companies, whose experience is so large on such points, very generally feel called upon to reject applicants for life assurance, whose apparent health may be undoubted, when several cases of phthisis have occurred among the members of the family.

Some Companies, indeed, think that it is safer to reject the case when the mother or father, or even one brother or sister, has died from this disease, if the applicant be young—say under 45.

In Walker's work on "Intermarriage," another theory is broached—viz., that, under certain restrictions, the male gives to the progeny the external or locomotive organs, and the female the internal or vital organs.

Arguing from the analogy of breeding among animals, this is more than a mere theory; the fact is well known to breeders of stock. So much, indeed, do certain known laws with respect to propagation prevail, and so thoroughly have they been made the subject of scientific investigation, that a cattle-breeder can produce, within certain limits, almost any class of animal he desires.

If we recognise the truth of this second theory, the necessity for extreme caution, on the part of Life Assurance Companies, in accepting the lives of individuals whose mothers have died from any hereditary disease, becomes clearly apparent. Still, arguing from what has been proved to be the case with respect to animals, Assurance Companies might, with reason, carry their inquiries into the family history of lives proposed for assurance much further than they have yet thought of doing.

It would, perhaps, startle a person desirous of assuring his life, to ask him whether his mother had been married previously to her marriage with his father, and if so, whether her former husband died of phthisis; and yet this would not be by any means a ridiculous inquiry.

It is a fact quite beyond dispute, and one to which public attention was first drawn by Lord Morton in the *Philosophical Transactions*, that the female retains traces of the influence of a prior impregnation, and transmits the same to a second, third, and even fourth progeny.

This has been clearly proved to be the case with horses, mules, sheep, dogs, pigs, and fowls; and what is most extraordinary in the matter is, that it is not necessary that a prior impregnation, in order to influence a subsequent one, should have resulted in the production of progeny.

In illustration of this, I may mention two authentic cases communicated to the Newcastle Farmers' Club by Mr. Reginald Orton, a surgeon at Sunderland; the first being the case just referred to as having been brought before the public by Lord Morton, who allowed a quagga he possessed to breed with a thorough-bred chestnut mare. The produce was a quagga mule, having the stripes, and, in many respects, the characteristics of the male parent. The next season the same mare was allowed to breed with a black Arab horse, and the result was, to the astonishment of the owner, a foal bearing strongly the marks of the quagga; and this effect continued to be visible through three successive foals produced by horses.

The second case is recorded in the *Transactions of the Royal Society*, and is perfectly analogous to the first. It had reference to a mare, the property of Sir Gore Ousley, which was allowed to breed with a zebra. The result was an animal bearing the zebra stripes. The mare next bred with a blood-horse, and produced a striped foal. The following year the same thing happened again.

A precisely similar result has been obtained in the case of other animals.

I mentioned that it had been shown, by experiments with animals, that a prior impregnation need not necessarily have resulted in the production of progeny, in order that evidences of it may be transmitted to a subsequent generation. Of course, with human beings, if there were any children of a first marriage, and phthisis showed itself in them, the case would be stronger; but the result, according to this theory, would be the same in the case of a *primipara*, as of a widow who had borne children.

With respect to animals, the fact under consideration is undoubted; and if we may fairly argue by analogy that the same holds for the human species, there is, probably, some reason to believe that we may, in this way, account for some of those sad but inscrutable cases which we all of us see happen occasionally among our friends and relations, in which phthisis comes on suddenly and unexpectedly, without our being able to trace either any hereditary tendency to the disease, or to find any reason to account satisfactorily for the origin of the affliction.

Should our reasoning be correct, the desirableness of marriage with a widow whose husband has died of phthisis or other hereditary disease, may, at least, be questioned; and, according to what has been said, whether she had borne children to her first husband or not; and possibly the attention of those engaged in the conduct of life assurance business may not inappropriately be directed to the subject.

With the view to confirm the truth of some of the foregoing opinions as to the effect of occupation on phthisis, I applied to the authorities of the Hospital for Consumption and Diseases of the Chest, at Brompton, for some statistics on the subject; and, through the kindness of the medical committee of the hospital, and of the resident medical officer, Mr. Vertue Edwards, I have been furnished with a list of the occupations of 557 male and 318 female in-patients who died of phthisis, or some disease of the chest, in the hospital in the ten years from January, 1850, to December, 1859. It is necessary to confine our attention to the in-patients, as the results of the cases of the out-patients cannot be ascertained. Although the sum of these numbers, which amounts to 875, forms but a small portion of the numbers recorded under similar heads in the Registrar's Reports, the list is sufficiently extensive to show which are the conditions of life in London that tend to the production of the particular class of diseases treated in this hospital.

In considering any records of this nature, we must take into account the situation, apart from the cause of the disease, in which the persons who are likely to become inmates of such an institution are placed.

We are at first struck by the number of domestic servants, both male and female—the latter particularly—who have died in the hospital, and we are not aware of any particular predisposing cause to phthisis in their case; indeed, in comparison with almost all the other classes in the list, the condition of domestic servants, as a class, contrasts very favourably; yet we find this class contributing the greatest number of deaths—viz., males 78, and females 192, or 14 and 60 per cent. respectively of the whole cases under observation.

On reflection, however, we see that this is the class, more than all others, likely to be sent to the hospital. Their illness comes on under the very eyes of their employers, who are, for the most part, willing, as well as able, to gain admission for their servants.

We may, therefore, consider that the highest classes on this list are those of labourers, among males, and of needlewomen, milliners and dressmakers, and other similar workers for shops, among females.

These classes contribute respectively 14 and 20 per cent. of the whole number of cases; next in order follow governesses and teachers.

This is just what we might naturally expect, that those who fare the hardest and have the greatest struggle to gain a livelihood, are among the first to succumb to the great malady of the country; and, further, in proportion to their poverty will they be the most likely classes to be left to die in a hospital, while the classes a little above them in the social scale will be more likely to be removed by their friends when their cases are found to be incurable.

The other unhealthy occupations as tested by these returns, arranged in order of unhealthiness, are, among males, those of clerks, carpenters, shoemakers, tailors, porters, drapers' assistants, painters, gardeners, soldiers, sailors, bricklayers, engineers, cabinet makers, bakers, policemen, and compositors; and, among females, governesses, teachers and schoolmistresses, laundresses and ironers.

With some slight exceptions, these, too, follow very much the order that we might expect.

We are not surprised to find clerks, shoemakers, tailors, and drapers' assistants, high in the list, seeing that their employment is of a sedentary nature; that these classes have very little opportunity for active exercise in the open air, and that the three first classes are not only engaged in sedentary employment, but such as, in addition, necessitates stooping very much over their work—the clerks over their desks, against which they most unwisely press their chests, to the very serious injury of the thoracic viscera, and the tailors and shoemakers over their stitching; the injury to the latter, besides, is increased by the pressure of the last against the chest, to which I have before referred.

The long hours during which the drapers' assistants work—the close, hot, crowded, gas-laden shops in which their lives are passed—the constant standing posture, in combination with the almost total impossibility of taking out-door exercise in the daytime—render this class particularly prone to phthisis. The mortality from this cause, in the large metropolitan drapers' shops, is said to be very great. The want of daylight in the work-rooms in which a considerable portion of the labouring classes perform their daily avocations, is stated to conduce to this disease.

It is satisfactory to see that there is just beginning to be some slight improvement in respect to the long hours during which these shops are open; and some large establishments have, in a very praiseworthy manner, instituted libraries and reading-rooms on their premises for the use of those employed.

The number of deaths recorded in the hospital returns, particularly among persons following other callings than the four classes I have enumerated, is too small for us to deduce much from it, even by comparison with the number of persons employed in the different trades, and which the Census returns of 1851 give us the means of knowing.

By combining together, however, the numbers of deaths stated to have happened in the hospital from phthisis, among persons working in metals—such as engineers, watchmakers, smiths of all kinds, cutlers, optical instrument makers, and the like—we find the total number proportionately very high; in fact, this class compares, for unhealthiness of occupation, with clerks, who stand almost at the head of the list—each class producing, in fact, 5½ per cent. of the whole mortality from this disease; and thus we are enabled, to some extent, to confirm, from the statistics of the hospital, the opinion as to the injurious effect upon the lungs of the inhalation of metallic particles.

No report has yet been issued by the authorities of the hospital of the result of the last ten years' experience to which I have just been alluding, in respect of which certain information has been furnished to me.

An elaborate medical report for the first six years, however—viz., from the establishment of the hospital in September, 1842, to the 31st of December, 1848—has been issued, and to this I have been kindly allowed access.

About the same number of in-patients are included in this period as in that embracing the last ten years; the exact number was 888, and consisted of 542 males and 346 females.

The out-patients numbered in all 10,051, but those treated for phthisis amounted only to 3,470—viz., males 2,137, and females 1,333.

The result of the medical inquiry based upon the facts recorded in the above cases, showed that there was a greater liability to phthisis in males than in females. I mention this, as the result is stated to be not in accordance with the opinion entertained on this subject by writers of authority in this country or on the continent.

The fact that the female population in London, during the period under observation, exceeded that of the males, was not lost sight of in the investigation.

The intensity of the disease, judging from the hospital statistics, appears to be between the ages of 25 and 35 for males, and at ages a little younger for females. The unhealthy occupations seem to follow very much the same order as those in the more recent period, and the results tend to confirm, to a very great extent, our preconceived views on the subject; and the more satisfactorily, as the number of cases under observation which were classified under the heads of the occupations of the patients that died of phthisis embraced 4,358 cases—viz., males 2,679, and females 1,679—or about five times as many as those that I have considered previously. Among the males we find the class of labourers, as before, at the head of the list; next come clerks, warehousemen and shopmen, mechanics, servants, tailors, carpenters, shoemakers, coachmen and cabmen, printers and compositors, painters and glaziers, weavers and glovers, bakers, and butchers; and among the females we find, as before, a very large and probably undue proportion of servants; then follow, as before, needlewomen, and those engaged in similar occupations, laundresses and governesses. Of course, we cannot accurately compare the relative mortality from any particular disease among persons following different occupations, unless we know the respective numbers engaged in those occupations.

An investigation of this nature would lead us further into the details of the question than is contemplated in this paper.

The question of the contagious nature, or otherwise, of phthisis, as bearing upon the production of this disease, is not an unimportant one. The difference of opinion, however, on this point appears to be very great, and the evidence on the subject to be very contradictory. As long, however, as the question admits of a doubt, it would certainly be well to be on the safe side, and, at all events, to avoid needless exposure to contagion.

The medical report of the hospital contains the results of a most interesting investigation into the question of hereditary predisposition to phthisis.

The information which is the result of such inquiries as these cannot but be of great interest to those connected with the business of life assurance, and of the highest importance to the Companies themselves, if they wish, not as a matter of course, to reject applicants for life assurance in whom an hereditary taint is suspected; in fact, if they desire to act upon principles which are the result of actual inquiries, instead of treating the cases brought before them in an arbitrary and unscientific manner, as they are now very much obliged to do.

With reference to the transmission of the disease, we learn from the report that it has been observed that one or more of several children of the same individuals may exhibit traces of the disease of their parents, and yet the other children of the family, though not apparently diseased themselves, may, on becoming parents, transmit to their offspring the elements of the disease, which only requires some exciting cause for its development. Thus a diseased parent in one generation will have offspring to all appearance healthy, and in the next generation an apparently healthy parent will be found to have diseased children.

The result of the inquiry of the medical officers of the Brompton hospital, as to the proportion of cases on the books in which hereditary taint could be traced, showed that out of 1,010 cases, comprising 669 males and 341 females, 122 males and 124 females, forming 18 and 36 per cent. respectively of the whole, or 24½ per cent. of males and females combined, were born of phthisical parents; or, in other words, 1 in every 4 patients, nearly, of the 1,010 cases under observation was traced to be hereditarily predisposed to the disease. It appears, too, that females are more likely to inherit the disease than males, in the proportion of 2 to 1. With the view to show how very large is the comparative proportion who appear to inherit phthisis from their parents—and, accordingly, to show how peculiarly severe the power of the hereditary transmission of this disease is—a comparison was instituted with the similar power in cases of insanity, which is also known to be, unhappily, too frequently transmitted through successive generations; and the result was, that 11·9 per cent. males and 13·4 per cent. females—or, combined, 12½ per cent. of the cases under observation—were born of insane parents. The probability, therefore, of the hereditary transmission of phthisis, as compared with that of insanity, is, taking both sexes together, as 2 to 1; and while the probability of inheriting phthisis, as just shown, is twice as great among females as among males, that of a similar transmission of insanity is only 1½ per cent. greater.

(*To be continued.*)

CORRESPONDENCE.

ON A METHOD OF USING THE "TABLE OF QUARTER SQUARES."

To the Editor of the Assurance Magazine.

SIR,—Allow me to call your attention, and that of your readers, to a method of using the "Table of Quarter Squares" computed by me and published in 1855,* which, although not pointed out in the introduction to that work, is one which will extend the usefulness of the table, and, in certain cases, materially diminish labour.

A constant factor is of frequent occurrence in some of the calculations of an actuary; for my present purpose it will be sufficient to instance the expression for the value of a policy when the premium is just due and not paid, viz.—

$$1-\frac{1+a_{m+n}}{1+a_m}=1-(1+a_{m+n})\left(\frac{1}{1+a_m}\right),$$

in which the term $\frac{1}{1+a_m}$ is constant, whatever may be the value of the other factor. Supposing a computer to be about to form a table of the values of a policy for a series of years—say from 1 to n years—it will manifestly be advantageous if he can save one reference to the table in each calculation.

---

* *Table of Quarter Squares of all Integer Numbers up to* 100,000, *by which the Product of Two Factors may be found by the aid of Addition and Subtraction alone.* C. & E. Layton, Fleet Street.